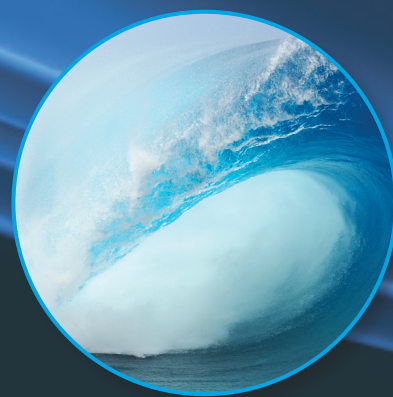


U.S. Department of Energy Wind and Water Power
Program Funding in the United States:

CONVENTIONAL HYDROPOWER PROJECTS

Fiscal Year 2008 - 2010



Conventional Hydropower Projects



iStock/#3939554

Introduction

Wind and Water Power Program

The Wind and Water Power Program (WWPP), within the U.S. Department of Energy's (DOE's) Office of Energy Efficiency and Renewable Energy (EERE), supports the development, deployment, and commercialization of wind and water power technologies. The Program works with a variety of stakeholders to identify and support research and development (R&D) efforts that improve technology performance, lower costs, and—ultimately—deploy technologies that efficiently capture the abundant wind and water energy resources in the United States. The WWPP is one program that contains two distinct focus areas: wind and water. The Wind Power Program and the Water Power Program operate as integrated, but separate sub-programs within WWPP.

From Fiscal Year (FY) 2008 to FY 2010, WWPP provided R&D funding across eight broad areas:

1. Conventional Hydropower Projects
2. Marine and Hydrokinetic Projects
3. Offshore Wind Projects
4. Wind Turbine Projects
5. Wind Integration Projects
6. Environmental Impacts of Wind Projects
7. Wind Market Acceptance Projects
8. Wind Workforce Development Projects.

The breakdown of WWPP funding is presented in a series of reports that showcase the projects funded in each of the eight above-mentioned areas.

Conventional Hydropower

Moving water is a powerful source of energy that is harnessed to provide clean, fast, and flexible electricity generation. Conventional hydropower is currently the largest source of renewable electricity world-wide and represents a reliable and domestic resource that can

power millions of American homes and businesses. Conventional hydropower energy has been used in the United States since the 1880s and currently produces 6-7% of the nation's total electricity.¹ DOE estimates that the United States possesses significant additional hydroelectric generating capacity, both at existing dams and in man-made waterways.

The Water Power Program helps industry harness this renewable, emissions-free resource to generate environmentally sustainable and cost-effective electricity. Through support for public, private, and non-profit efforts, the Water Power Program promotes the development, demonstration, and deployment of advanced hydropower devices and pumped storage hydropower applications. These technologies help capture energy stored by diversionary structures, increase the efficiency of hydroelectric generation, and use excess grid energy to replenish storage reserves for use during periods of peak electricity demand. In addition, the Water Power Program works to assess the potential extractable energy from domestic water resources to assist industry and government in planning for our nation's energy future. From FY 2008 to FY 2010, DOE's Water Power Program announced awards totaling nearly \$42.4 million to 14 projects focused on conventional hydropower. Table 1 provides a brief description of these projects.

There are three sources of funding for WWPP conventional hydropower projects covered in this report: Congressional Appropriations for Funding Opportunity Announcements (FOAs), Congressionally Directed Projects (CDPs), and the American Recovery and Reinvestment Act of 2009 (Recovery Act).

The Water Power Program has rapidly expanded since it was established in 2008. From Fiscal Year (FY) 2008 to FY 2009, congress increased the Water Power Program budget from nearly \$10 million in FY 2008 to more than \$35 million in FY 2009.

Types of Funding Sources

The Wind and Water Power Program's (WWPP's) research and development (R&D) projects are financed through two primary sources of funding: Congressional Appropriations and Congressionally Directed Projects (CDPs). Congressional Appropriations determine the operating budgets for each EERE program. WWPP-funded R&D projects are typically awarded to recipients as grants through competitive Funding Opportunity Announcements (FOAs) that are dedicated to specific topic areas. CDPs are also funded by Congress, but are outside of the annual federal budget process. Frequently, there is a cost-share requirement for recipients of both competitive FOA grants and CDPs.

In addition to these two primary funding sources, WWPP may be financed directly through specific legislation passed by Congress. In FY 2009, for example, Congress passed the American Recovery and

Reinvestment Act of 2009 (Recovery Act). A portion of Recovery Act funding was dedicated to WWPP's R&D projects.

WWPP also funds research projects at DOE's national laboratories through the laboratories' annual operating plans. This funding is not covered in this report. However, a national laboratory may be a partner on a project covered in this report. In these cases, the national laboratory is identified as a partner in the project description below.

The Small Business Innovation Research (SBIR) program, in DOE's Office of Science, provides competitive awards-based funding for domestic small businesses engaging in research and development (R&D) of innovative technology. SBIR has funded conventional hydropower R&D projects; however, these projects are not covered in this report.

Table 1: FY 2008 – FY 2010 Conventional Hydropower Project Descriptions^a

Project Recipient	Project Title	DOE Funding Amount	Funding Source
Advanced Energy Conversion, LLC	Hydropower from Wastewater	\$475,750	FY 2009 CDP
Project Description			
Advanced Energy Conversion, LLC (AEC) is designing a turbine that captures the kinetic energy of processed wastewater to generate electricity. Since electricity is often one of the largest operating costs at a wastewater treatment plant, generating on-site electricity at wastewater treatment plants has the potential to reduce energy costs. AEC has patented National Aeronautics and Space Administration award-winning technology that it will utilize to develop an integrated hydroelectric turbine generator to convert kinetic energy in an effluent stream (or any other low-pressure flow) into electricity. The turbine technology is expected to help reduce energy costs associated with wastewater treatment by generating onsite renewable electricity. The project examines the turbine design in both small facilities that process less than 1 million gallons of water per day (MGD) and large facilities that process more than 75 MGD.			
Project Recipient	Project Title	DOE Funding Amount	Funding Source
Alabama Power Company	Upgrades to Alabama Power Hydroelectric Developments	\$6,000,000	Recovery Act Hydroelectric Facility Modernization FOA
Project Description			
Alabama Power Company is upgrading four units at three of its hydropower facilities located on the Coosa River System. The four-unit upgrades include the installation of high-efficiency turbines to increase the efficiency and reliability of the individual units and the Coosa River System as a whole. The Coosa upgrades will provide additional low-cost renewable energy generation to meet demand and are expected to increase annual generation by 7.3%. In addition, the new units will reduce fish injury and turbine mortality, while increasing reliability and reducing maintenance costs.			
Project Recipient	Project Title	DOE Funding Amount	Funding Source
Alcoa, Inc.	Tapoco Project: Cheoah Upgrade	\$12,950,000	Recovery Act Hydroelectric Facility Modernization FOA
Project Description			
Alcoa Power Generating Incorporated, a fully owned subsidiary of Alcoa Incorporated, is implementing major upgrades at its Cheoah hydroelectric facility near Robbinsville, North Carolina. The planned upgrades include the installation of two new high-efficiency turbines, generators, and transformers, as well as improvements to the balance of plant equipment and preparation work for the installation of two additional units. The proposed two-year project is expected to increase site-wide generation by 47,200 megawatt-hours (MWh) annually. Completion of the full four-unit modification is expected to result in a 28% increase in generating capacity—from 88 MW to 110 MW—and add 40 to 50 years to the facility's expected lifespan without requiring modifications to the dam.			

^a DOE Funding Amounts identified in this table reflect the total DOE funding planned for award to each project for the total period of project performance that may span multiple years. DOE Funding Amounts shown in this table may be subject to change.

Table 1: FY 2008 – FY 2010 Conventional Hydropower Project Descriptions^a

Project Recipient	Project Title	DOE Funding Amount	Funding Source
City of Boulder	Modernization of the Boulder Canyon Hydroelectric Project	\$1,180,000	Recovery Act Hydroelectric Facility Modernization FOA

Project Description

The City of Boulder is modernizing the 100-year-old Boulder Canyon Hydroelectric Project, originally constructed in 1910. With significant redirection of the historic water flow to meet the city's current municipal and minimum instream flow uses, the two existing 10 MW Boulder Canyon Hydroelectric turbines/generators are too large to operate efficiently and are at the end of their useful lifetime. With this funding, the city will install a single new turbine/generator unit that is appropriately sized (approximately 5 MW) for the available water flow. This unit is expected increase generation by as much as 30% and turbine efficiency by 18 to 48%, depending on flow. Over its 50-year life, the new unit is expected to generate approximately 500,000 MWh that would not otherwise be produced. The project will increase generation and efficiency; improve safety for personnel and equipment; improve environmental protection; modernize and integrate control equipment into the city's municipal water supply system; preserve significant historic engineering data; and contribute to economic recovery through the creation or preservation of 10 full-time jobs for one year.

Project Recipient	Project Title	DOE Funding Amount	Funding Source
City of Little Rock	Hydroelectric Facility Improvement Automated Intake Clearing Equipment and Materials Management	\$450,000	Recovery Act Hydroelectric Facility Modernization FOA

Project Description

The City of Little Rock is upgrading a hydroelectric generation facility located at the Murray Hydroelectric plant on the Arkansas River. Currently, the facility experiences significant costs to collect debris that obstructs the intake on a regular basis and limits plant operation. The project will acquire and implement automated industrial equipment, including an intake maintenance device and wood grinder. The intake maintenance device will improve the plant's flow characteristics by continuously clearing the intake channel of the often heavy volume of debris that comes downstream. The wood grinder will receive the tree limbs, tree trunks, and other organic debris removed by the intake maintenance device, minimizing the current need for burning debris, and thus reducing air pollution.

Project Recipient	Project Title	DOE Funding Amount	Funding Source
City of Tacoma	North Fork Skokomish Powerhouse at Cushman No. 2 Dam	\$4,671,304	Recovery Act Hydroelectric Facility Modernization FOA

Project Description

The City of Tacoma is installing two Francis turbine/generator units adding approximately 3.6 MW of annual electrical generation, increasing annual generation by 14%. The project is located at an existing dam, Cushman No. 2, which is part of the Cushman Hydroelectric Project owned by Tacoma Power. The installation of the new powerhouse will generate additional clean, renewable energy using currently diverted, but unutilized water flow. Because fish passage has been blocked since the construction of the two Cushman dams in the late 1920s, the project will develop an innovative fish collection and passage system that supports the reintroduction of Washington's endangered steelhead and salmon populations upstream of the Cushman Hydroelectric Project.

Project Recipient	Project Title	DOE Funding Amount	Funding Source
City of Quincy	Quincy Area Hydropower Project	\$490,070	FY 2009 CDP

Project Description

The City of Quincy is conducting feasibility studies to assess the viability of developing hydropower generation facilities by installing new Very Low Head (VLH) hydropower technology turbines within existing lock and dams on the upper Mississippi River near Quincy, Illinois. Based on initial studies in France, the VLH units meet all "fish-friendly" criteria, exceeding current U.S. technology. Upon completion of the project, the energy generated is expected to exceed the amount of electricity currently consumed by the city's facilities, water, wastewater, and street lighting. Excess capacity will be sold on the grid to provide the city with additional revenue. If the funded studies prove VLH is feasible at the suggested sites, the City of Quincy could be the first VLH installation in the United States.

Table 1: FY 2008 – FY 2010 Conventional Hydropower Project Descriptions^a

Project Recipient	Project Title	DOE Funding Amount	Funding Source
Electric Power Research Institute	“Fish-Friendly” Hydropower Turbine Development & Deployment: Phase II Preliminary Engineering & Model Testing	\$1,200,000	Advanced Water Power Projects FOA

Project Description

Electric Power Research Institute is completing the remaining developmental engineering required for a new hydropower turbine concept. A key aspect that differentiates the new turbine and advanced runner from existing turbines is the technology’s “fish-friendly” design. Upon completion of the project, Electric Power Research Institute will possess a robust, fish-friendly design that is ready for field demonstration and is commercially viable.

Project Recipient	Project Title	DOE Funding Amount	Funding Source
Electric Power Research Institute	Quantifying the Full Value of Hydropower in the Transmission Grid	\$2,577,975	Advanced Water Power Projects FOA

Project Description

Electric Power Research Institute, in partnership with Oak Ridge National Laboratory and Sandia National Laboratories, is also developing and demonstrating an innovative approach for quantifying and maximizing the benefits provided by conventional and pumped-storage hydroelectric projects to transmission grids. The project will establish a wide-area modeling approach, build a database, and develop and simulate scenarios in support of defining a new methodology for planning and applying hydropower assets to support the integration of variable renewables to the transmission grid.

Project Recipient	Project Title	DOE Funding Amount	Funding Source
Hydro Research Foundation	Hydro Fellowship Program	\$2,997,050	Advanced Water Power Projects FOA

Project Description

Hydro Research Foundation is establishing a competitive Hydro Fellowship Program designed to stimulate new student and academic interest in conventional or pumped-storage hydropower research and careers. The Hydro Fellowship Program expects to award fellowships to approximately 27 graduate- and doctoral-level students for two-year periods of study in the fields of hydropower-related engineering and environmental sciences. The fellowship is open to students across the nation.

Project Recipient	Project Title	DOE Funding Amount	Funding Source
Incorporated County of Los Alamos	Installation of a Low-Flow Unit at the Abiquiu Hydroelectric Facility	\$4,558,344	Recovery Act Hydroelectric Facility Modernization FOA

Project Description

The Incorporated County of Los Alamos Department of Public Utilities (DPU) owns and operates the Abiquiu Hydroelectric Plant located in Rio Arriba County, New Mexico. DPU is constructing a powerhouse addition and installing a new 3 MW low-flow turbine generator to the existing hydroelectric plant. The project is expected to increase total plant power generation by 22% from 13.8 MW to 16.8 MW. The addition of this equipment will allow for year-round generation of power during the Rio Chama low-flow winter season, as well as increased power generation throughout the remainder of the year. The project is one aspect of Los Alamos County’s commitment to sustainable public utility systems (electric, water, gas, and wastewater) through its Los Alamos Green utilities initiative and resource conservation programs.

Table 1: FY 2008 – FY 2010 Conventional Hydropower Project Descriptions^a

Project Recipient	Project Title	DOE Funding Amount	Funding Source
Minnesota Power	Fond du Lac Hydroelectric Facility Modernization	\$815,995	Recovery Act Hydroelectric Facility Modernization FOA

Project Description

Minnesota Power is upgrading a 12 MW turbine/generator unit at the Fond du Lac hydroelectric facility, constructed in 1924. The project will return the existing hydroelectric generator to its original nameplate capacity by overhauling the unit to increase annual generation by 3,000 MWh from current operation. Replacement of the original cast iron runner and wicket gates with a new state-of-the-art steel runner and steel gates is estimated to improve annual generation by an additional 3,000 MWh based on 10-year averaged data for a total of 6,000 MWh or 12% increase in annual generation over the present.

Project Recipient	Project Title	DOE Funding Amount	Funding Source
Pennsylvania State University	DOE/PSU Graduate Student Fellowship Program for Hydropower Research	\$3,000,000	Advanced Water Power Projects FOA

Project Description

The Pennsylvania State University (PSU) and American Hydro Corporation (AHC) are establishing a competitive DOE/PSU Fellowship Program to support graduate student research directly related to the hydropower industry. Fellows in the program will receive a highly competitive stipend package and a faculty mentor/advisor that can help identify and support the fellow's pertinent and challenging area of hydropower research. PSU faculty and representatives from AHC, DOE, and an electric utility company will review fellowship applications and expect to award a minimum of approximately 10 fellows with approximately \$100,000 per year per project. The program will provide the hydropower industry with new research and hydropower experts that can support the development of a more efficient use of our nation's hydroelectric power facilities, thereby reducing air pollution and greenhouse gas emissions.

Project Recipient	Project Title	DOE Funding Amount	Funding Source
Pleasant Grove County	Project Blue Energy	\$1,000,000	FY 2010 CDP

Project Description

Pleasant Grove County's Project Blue Energy will create renewable energy from existing community water sources with an innovative micro-hydro electric system. The project aims to generate electricity more efficiently than traditional micro hydro-electric systems by generating electricity throughout a broad range of water flow and pressure conditions. In addition, the project will provide technical, financial, and policy templates for other communities to replicate a similar project. Upon completion of the project, Pleasant Grove County will demonstrate the value of harnessing clean and renewable energy sources, and storing and deploying the electricity in an innovative community model.



iStock/#1070020

Conventional Hydropower Funding Distribution

DOE funded 14 Conventional Hydropower projects through the Water Power Program from FY 2008 to FY 2010. These projects are categorized in the following sections by activity area, topic area, geographic region and division, state, recipient type, and funding source.

Funding by Activity Area and Topic Area

The Water Power Program’s R&D efforts fall under two activity areas: Technology Development and Market Acceleration. The Water Power Program’s Technology Development projects are aimed at reducing the technical barriers to conventional hydropower device development, improving device reliability and performance, and enhancing the understanding and evaluation of various technology types. The Water Power Program’s Market Acceleration projects are aimed at reducing the time and costs associated with siting water power projects; better quantifying the potential magnitude, costs, and benefits of water power generation; and identifying and addressing other barriers to deployment. When total conventional hydropower funding is categorized by activity area, Technology Development activities received nearly 80% of the funding and Market Acceleration activities received the remaining 20%.

Within the Technology Development and Market Acceleration activity areas, the Water Power Program funds particular topics in priority areas within the Program. Capacity and Efficiency Equipment Upgrades was the largest topic area in terms of total funding in the Technology Development activity area, largely due to the FY 2009 Recovery Act FOA, “Hydroelectric

Seventy-two percent of WWPP’s conventional hydropower funding for projects announced in FY 2008 to FY 2010 is directed at hydroelectric facility modernization through the American Recovery and Reinvestment Act of 2009 (Recovery Act). Modernization efforts are dominated by projects that increase hydropower facilities’ generating capacity and improve plant and equipment efficiency. Alcoa Incorporated was awarded \$12.95 million for the modernization of the Cheoah Hydroelectric Facility, the largest hydropower award resulting from the Recovery Act.

Facility Modernization.” University Research Fellowships represented the largest topic area funded by the Market Acceleration activity area. Table 2 below provides details on the conventional hydropower funding for each topic area within the Technology Development and Market Acceleration activity areas.



iStock/#3912666

Table 2: FY 2008 – FY 2010 Conventional Hydropower Funding Distribution by Activity Area & Topic Area

Activity Area	Total Funding	Percent of Total
Technology Development Subtotal	\$33,791,463	79.8%
Capacity and Efficiency Equipment Upgrades	\$30,175,643	71.2%
Advanced Turbine Design and Testing	\$1,200,000	2.8%
Small Hydropower	\$1,000,000	2.4%
Powering Non-Powered Dams	\$490,070	1.2%
Audits and Feasibility Studies	\$475,750	1.1%
Operational Upgrades	\$450,000	1.1%
Market Acceleration Subtotal	\$8,575,025	20.2%
University Research Fellowships	\$5,997,050	14.2%
Hydropower Grid Services	\$2,577,975	6.1%
Total	\$42,366,488	

Funding by Geographic Region & Division

Conventional hydropower projects were awarded in each of the four geographic regions. Table 3 provides details on how the Program's funding was distributed within regions and divisions. The geographic regions and divisions used to present the distribution of WWPP's funding are

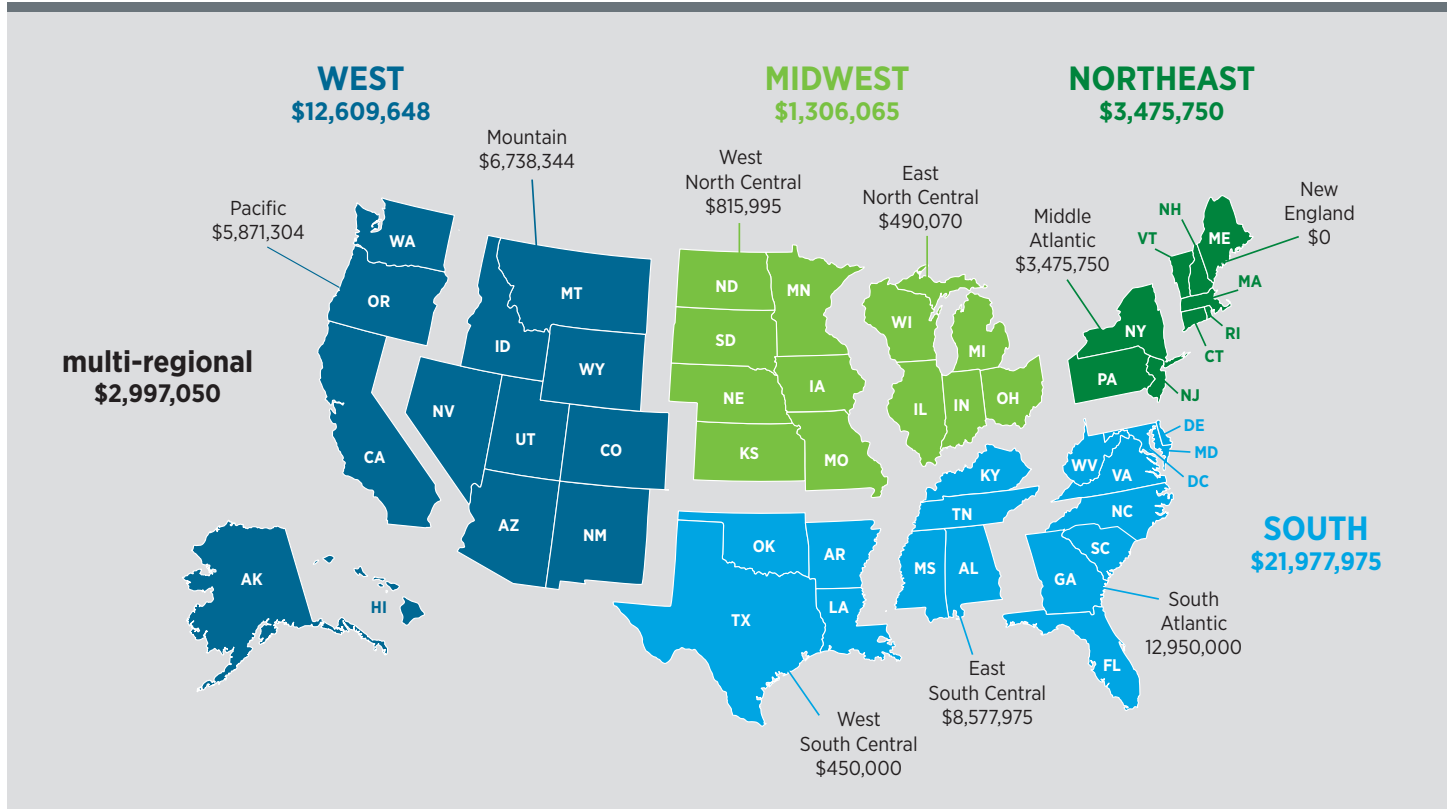
based on the U.S. Census Regions and Divisions.² One project spanned several regions and divisions and is thus categorized as multi-regional.

Exhibit 1 provides a map that shows how the Program's funding was distributed throughout the United States.

Table 3: FY2008 – FY2010 Conventional Hydropower Funding by Geographic Region & Division

Region	Region Total Funding	Division	Division Total Funding
South	\$21,977,975	South Atlantic	\$12,950,000
		East South Central	\$8,577,975
		West South Central	\$450,000
West	\$12,609,648	Mountain	\$6,738,344
		Pacific	\$5,871,304
Northeast	\$3,475,750	Middle Atlantic	\$3,475,750
		New England	\$0
Midwest	\$1,306,065	West North Central	\$815,995
		East North Central	\$490,070
multi-regional ^b	\$2,997,050	national	\$2,997,050
		Total	\$42,366,488

Exhibit 1: Conventional Hydropower Funding by Geographic Region & Division



^b The multi-regional category is not used in the U.S. Census regions and divisions. The multi-regional category reflects WWPP funding awarded to projects occurring across multiple divisions and regions.



iStock/#4200712

Funding by State

Thirteen states have each received funding for conventional hydropower projects through the Water Power Program. Funding awarded to one project is disbursed through fellowships eligible to students in many states, and is categorized as multi-state. Table 4 outlines funding by state.

Combined, North Carolina, Alabama, and Washington received more than 50% of total funding for conventional hydropower projects. All three projects were funded by the Recovery Act and are working to modernize hydroelectric facilities in these states.

Table 4: FY 2008 – FY 2010 Conventional Hydropower Funding Distribution by State

State	Total Funding
Alabama	\$6,000,000
Arkansas	\$450,000
California	\$1,200,000
Colorado	\$1,180,000
Illinois	\$490,070
Minnesota	\$815,995
multi-state ^c	\$2,997,050
New Mexico	\$4,558,344
New York	\$475,750
North Carolina	\$12,950,000
Pennsylvania	\$3,000,000
Tennessee	\$2,577,975
Utah	\$1,000,000
Washington	\$4,671,304
Total	\$42,366,488

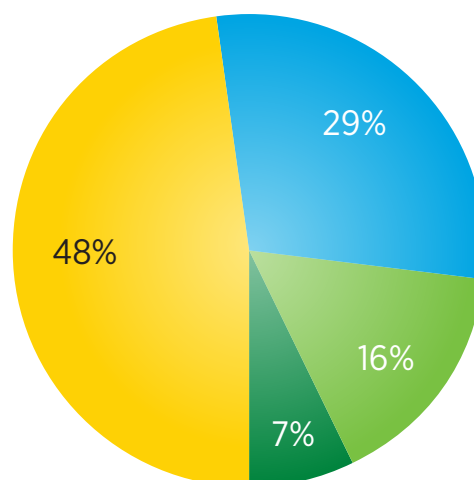
Funding by Recipient Type

DOE funds a variety of recipient types, including private industry, nonprofit organizations, universities and community colleges, investor-owned utilities and public utilities, local and state governments, as well as DOE national laboratories, other federal agencies, and interstate government agencies.

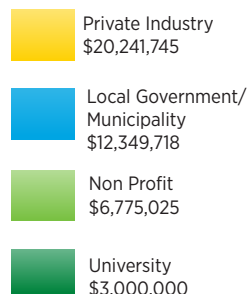
Nearly half of the total funding was awarded to private industry and about one-third to local governments or municipalities. The remaining funds were awarded to three nonprofit organizations and one university. Exhibit 2 provides these details by recipient type.

The Recovery Act funding was split between private-industry and local governments and/or municipalities. Private industry-lead projects received nearly \$19.8 million of the total \$30.6 million and local governments and/or municipalities received just over \$10 million in funding.

Exhibit 2: FY 2008 – FY 2010 Conventional Hydropower Funding Distribution by Recipient Type



Total funding:
\$42,366,488



Industry projects awarded to private-sector companies dominate the Program's conventional hydropower investment portfolio, representing 50%—or \$21.2 million of total funding.

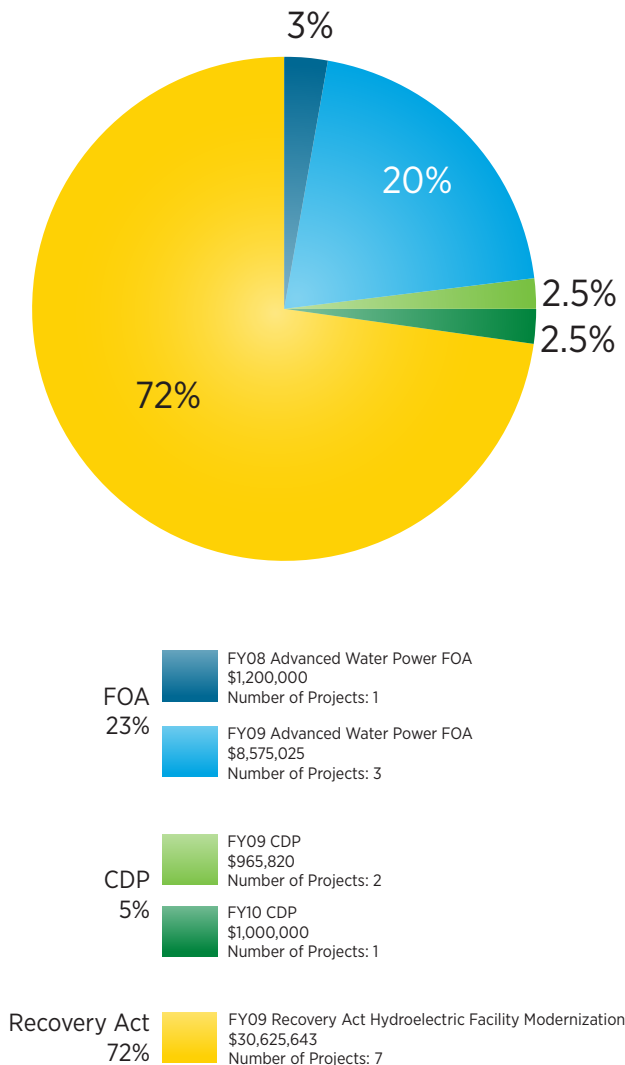
^c The multi-state category reflects WWPP funding awarded to projects occurring across multiple states.

Funding Sources

Exhibit 3 below provides details on the sources of funding for the Water Power Program's 14 conventional hydropower projects awarded from FY 2008 to FY 2010.

Between FY 2008 and FY 2010, nearly \$9.8 million was awarded to four conventional hydropower projects from Congressional Appropriations through two Advanced Water Power FOAs. An additional \$1.97 million was awarded to three conventional hydropower projects through Congressionally Directed funds, and \$30.6 million was awarded to seven projects from the Recovery Act through one FOA.

Exhibit 3: FY 2008 – FY 2010 Funding Sources for Conventional Hydropower R&D Projects



Anticipated Accomplishments

The Water Power Program provided nearly \$42.4 million in funding for conventional hydropower projects from FY 2008 to FY 2010, with numerous projects operating over multiple years. The Water Power Program anticipates significant key accomplishments in increased hydroelectric generation and equipment efficiency; advanced turbine development; support for hydropower research fellowships and professional opportunities; environmental benefits for fish populations; and research to support hydropower integration with the transmission grid.

A few of the Program's anticipated project accomplishments include the following:

- The increased generation resulting from the Recovery Act-funded hydroelectric modernization projects is estimated to exceed 135,000 MWh annually; enough to meet the annual electric usage of more than 10,000 average U.S. homes at an estimated incremental cost of less than \$0.04 per kilowatt hour.
- The two university research fellowship programs are expected to revitalize interest in conventional hydropower, provide the hydropower industry with skilled workers, and support U.S. hydropower innovation and leadership in the world. Over 30 professionals in these programs will receive advanced degrees and enter the hydropower workforce by the second quarter (Q2) of FY 2014.
- The City of Tacoma will have completed an innovative fish handling and transportation system that aids fish migration and allows for the reintroduction of fish into natural habitats in the State of Washington by Q1 of FY 2013.
- The Electric Power Research Institute and Alden Labs will install, test, and demonstrate that the Alden turbine is able to generate conventional hydropower energy with fish survival rates ranging from 98% to 100% in FY 2011.
- Advanced Energy Conversion, LLC will design and build a prototype turbine capable of capturing the energy from low-pressure flows (e.g., treated wastewater effluent exiting sewage treatment plants) by Q2 of FY 2012.

End Notes

¹ U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Wind and Water Power Program, *Water Power for a Clean Future*, DOE/GO-102011-3287. June 2011. <http://water.energy.gov/pdfs/51315.pdf>

² Energy Information Administration, U.S. Census Regions and Divisions. June 14, 2000. http://www.eia.doe.gov/emeu/regs/maps/us_census.html



Energy Efficiency &
Renewable Energy

EERE Information Center

1-877-EERE-INFO (1-877-337-3463)

www.eere.energy.gov/informationcenter

DOE/EE-0605 • August 2011

Printed with a renewable-source ink on paper containing at least 50%
wastepaper, including 10% post consumer waste.